

## CLAIMS

1. A method of determining the pixel drive signals to be applied to the pixels of an array of light emitting display elements (2) arranged in rows and columns, with a plurality of the pixels in a row being supplied with current simultaneously along a respective row conductor (26), the method comprising:
- 5 determining target pixel drive currents corresponding to desired pixel brightness levels based on a model of the pixel current-brightness characteristics;
- 10 modifying the target pixel drive currents to take account of:
- the voltage on the respective row conductor (26) at each pixel resulting from the currents drawn from the row conductor by the plurality of pixels; and
- the dependency of the pixel brightness characteristics on the
- 15 voltage on the row conductor at the pixel; and
- determining the pixel drive signals from the modified target pixel drive currents.
2. A method as claimed in claim 1, wherein each pixel is
- 20 programmed in a first phase and driven in a second phase, and wherein the step of modifying the target pixel drive currents further takes account of any differences in the current drawn by the pixels between the first and second phases.
- 25 3. A method as claimed in any preceding claim, wherein the step of modifying the target pixel drive currents comprises:
- applying an algorithm to the target pixel drive currents which represents the relationship between the currents drawn by the pixels in a row and the voltages on the row conductor at the locations of the pixels; and
- 30 scaling the resulting values using a value representing the dependency of the pixel brightness characteristics on the voltage on the row conductor.

4. A method as claimed in claim 3, wherein applying an algorithm comprises multiplying a vector of the target pixel drive currents for a row of pixels by the inversion of the matrix **M**, in which:

$$\mathbf{M} = \begin{bmatrix} -2 & 1 & & & \\ 1 & -2 & 1 & & \\ & \ddots & \ddots & \ddots & \\ & & 1 & -2 & 1 \\ & & & 1 & -2 \end{bmatrix},$$

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and wherein the number of rows and columns of matrix **M** is equal to the number of pixels in the row.

5. A method as claimed in claim 3 or 4, wherein each pixel comprises a current source circuit (22,24) which converts an input voltage to a current using a drive transistor (22), and wherein the scaling comprises using a value including terms derived from:

the voltage-current characteristics of the drive transistor (22); and  
the voltage-current characteristics of the light emitting display element (2).

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6. A method as claimed in claim 5, wherein the scaling comprises using a value further including a term derived from the resistance (**R**) of the row conductor.

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7. A method as claimed in claim 6, wherein the scaling comprises using a value  $(1-\alpha)R\lambda/(1+\lambda/\mu)$ , where

**R** is the resistance of the row conductor between adjacent pixels;

$\lambda$  is the slope of the drain-source current vs. drain-source voltage curve of the drive transistor;

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$\mu$  is the slope of the current vs. voltage curve of the display element;

and

$\alpha$  is the ratio of the current drawn by a pixel during a pixel programming phase to the current drawn by the pixel during display.

8. A method as claimed in claim 7, wherein the value  
 5  $(1-\alpha)R\lambda/(1+\lambda/\mu)$  used for scaling uses the slope of the drain-source current vs. drain-source voltage curve of the drive transistor and the slope of the current vs. voltage curve of the display element at the value of the first pixel drive current.

10 9. A method as claimed in claim 4, wherein the result of multiplying a vector of the target pixel drive currents for a row of pixels by the inversion of the matrix **M** is obtained by a recursive operation

$$F(n) = F(n-1) + \sum_{j=0}^{n-1} I(j) + F(0),$$

in which:

15  $F(n)$  is the  $n$ th term of a the vector result of multiplying the vector of the target pixel drive currents for a row of pixels by the inversion of the matrix **M**,  $F(0)$  being the first term; and

$I(j)$  is the target current for the  $j$ th pixel in a row, the first pixel being  $j=0$ .

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10. A method as claimed in claim 9, wherein:

$$F(0) = \frac{1}{N+1} \sum_{j=0}^{N-1} (N-j)I(j),$$

in which:

$N$  is the total number pixels in the row.

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11. A method as claimed in any one of claims 3 to 10, wherein the values representing the dependency of the pixel brightness characteristics on the voltage on the row conductor used for scaling are stored in a look up table (100)

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12. A method as claimed in claim 11, wherein the look up table (100) stores the values for a range of current values.

13. A method as claimed in claim 11 or 12, wherein the values of the look up table are updated over time to enable changes in pixel brightness characteristics over time to be modeled.

14. A method as claimed in claim 13, wherein updating of the look up table values is carried out based on analysis of the characteristics of pixel compensation modules (110, 112, 114) of the display.

15. A method of driving an active matrix array of current-addressed light emitting display elements arranged in rows and columns, comprising addressing each row of pixels in a sequence, the method comprising, for each row of pixels:

determining pixel drive signals for each pixel in the row using the method of any one of the preceding claims; and

applying the pixel drive signals to the columns of the display during a pixel programming phase for the row of pixels.

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16. A display device comprising an active matrix array of current-addressed light emitting display elements (2) arranged in rows and columns, comprising:

compensation circuitry for modifying the target pixel drive currents to take account of the voltage on the respective row conductor (26) at each pixel resulting from the currents drawn from the row conductor by the plurality of pixels and the dependency of the pixel brightness characteristics on the voltage on the row conductor at the pixel, the compensation circuitry comprising:

means (60,62,64,66,70,72,74,76,78,80,82,90,92) for applying an algorithm to the target pixel drive currents which represents the relationship

between the currents drawn by the pixels in a row and the voltages on the row conductor at the locations of the pixels; and

means (100,104) for scaling the resulting values using a value representing the dependency of the pixel brightness characteristics on the voltage on the row conductor.

17. A device as claimed in claim 16, wherein the means for applying an algorithm derives values corresponding to the multiplication of a vector of the target pixel drive currents for a row of pixels by the inversion of the matrix **M**, in which:

$$\mathbf{M} = \begin{bmatrix} -2 & 1 & & & \\ 1 & -2 & 1 & & \\ & \ddots & \ddots & \ddots & \\ & & 1 & -2 & 1 \\ & & & 1 & -2 \end{bmatrix},$$

and wherein the number of rows and columns of matrix **M** is equal to the number of pixels in the row.

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18. A device as claimed in claim 16 or 17, wherein each pixel comprises a current source circuit (22,24) which converts an input voltage to a current using a drive transistor (22), and wherein the means for scaling uses a value including terms derived from:

the current-voltage characteristics of the drive transistor; and  
the voltage-current characteristics of the light emitting display element.

19. A device as claimed in claim 18, wherein the drive transistor (22) and the light emitting display element (2) of each pixel are in series between the row conductor (26) and a common line.

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20. A device as claimed in claim 19, wherein the voltage scaling uses a value including terms derived from the drain-source voltage vs. drain-source current characteristics of the drive transistor.

5 21. A device as claimed in any one of claims 18 to 20, wherein the means for scaling uses a value further including a term derived from the resistance (R) of the row conductor.

22. A device as claimed in claim 21, wherein the means for scaling  
10 (100) uses a value  $(1-\alpha)R\lambda/(1+\lambda/\mu)$ , where:

R is the resistance of the row conductor between adjacent pixels;

$\lambda$  is the slope of the current vs. voltage curve of the drive transistor;

$\mu$  is the slope of the current vs. voltage curve of the display element;

and

15  $\alpha$  is the ratio of the current drawn by a pixel during a pixel programming phase to the current drawn by the pixel during display.

23. A device as claimed in claim 17, wherein the means for applying an algorithm derives values by a recursive operation

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$$F(n) = F(n-1) + \sum_{j=0}^{n-1} I(j) + F(0),$$

in which:

F(n) is the nth term of a the vector result of multiplying the vector of the target pixel drive currents for a row of pixels by the inversion of the matrix **M**, F(0) being the first term; and

25  $I(j)$  is the target current for the jth pixel in a row, the first pixel being j=0.

24. A device as claimed in claim 23, wherein:

$$F(0) = \frac{1}{N+1} \sum_{j=0}^{N-1} (N-j)I(j),$$

30 in which:

N is the total number pixels in the row.

25. A device as claimed in any one of claims 16 to 24, wherein the means for scaling (100) comprises a look up table.

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26. A device as claimed in claim 25, further comprising at least one pixel compensation module (110,112,114), and further comprising means for updating the values of the look up table to enable changes in pixel brightness characteristics over time to be modeled based on analysis of the characteristics of the pixel compensation module.

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27. Compensation circuitry for modifying target pixel drive currents for a display device which comprises an active matrix array of current-addressed light emitting display elements arranged in rows and columns having respective row and column conductors, the compensation circuitry comprising:

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means (60,62,64,66,70,72,74,76,78,80,82,90,92) for applying an algorithm to the target pixel drive currents which represents the relationship between the currents drawn by the pixels in a row and the voltages on the row conductor at the locations of the pixels; and

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means (100,104) for scaling the resulting values using a value representing the dependency of the pixel brightness characteristics on the voltage on the row conductor,

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the scaling taking account of the voltage on the respective row conductor at each pixel resulting from the currents drawn from the row conductor by the plurality of pixels and the dependency of the pixel brightness characteristics on the voltage on the row conductor at the pixel.

28. Compensation circuitry as claimed in claim 27, wherein the means for applying an algorithm derives values corresponding to the multiplication of a vector of the target pixel drive currents for a row of pixels by the inversion of the matrix **M**, in which:

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$$\mathbf{M} = \begin{bmatrix} -2 & 1 & & & \\ 1 & -2 & 1 & & \\ & \ddots & \ddots & \ddots & \\ & & 1 & -2 & 1 \\ & & & 1 & -2 \end{bmatrix},$$

and wherein the number of rows and columns of matrix **M** is equal to the number of pixels in the row.

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29. Compensation circuitry as claimed in claim 27 or 28, wherein the means for scaling comprises a look up table.